AD-A159 461 MATERIALS EVALUATION IN THE TRI-SERVICE THERMAL RADIATION TEST FACILITY(U) DAYTON UNIV OH RESEARCH INST D A GERDEMAN ET AL. 20 JUN 84 UDR-TR-84-62 1/1

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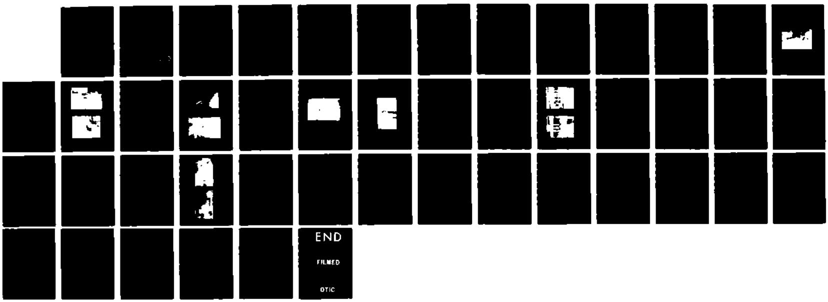

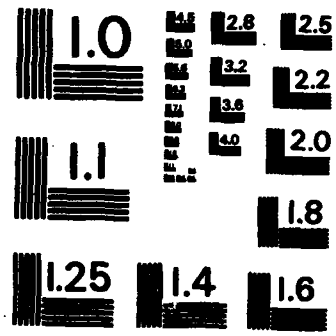
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MATERIALS EVALUATION IN THE TRI-SERVICE THERMAL RADIATION TEST FACILITY

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20 June 1984

Technical Report

CONTRACT No. DNA 001-83-C-0236

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SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE N/A since UNCLASSIFIED	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) UDR-TR-84-62	5. MONITORING ORGANIZATION REPORT NUMBER(S) DNA-TR-84-238
6a. NAME OF PERFORMING ORGANIZATION University of Dayton Document Control 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION Director Defense Nuclear Agency
6c. ADDRESS (City, State, and ZIP Code) Wright Brothers Br Post Ofc, Box 283 Dayton, OH 45409-0283	7b. ADDRESS (City, State, and ZIP Code) Washington, DC 20305-1000
8a. NAME OF FUNDING / SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER DNA 001-83-C-0236
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO: 62715H PROJECT NO: G54AMXG TASK NO: F WORK UNIT ACCESSION NO: DH006994

11. TITLE (Include Security Classification)
MATERIALS EVALUATION IN THE TRI-SERVICE THERMAL RADIATION TEST FACILITY

12. PERSONAL AUTHOR(S) Dennis A. Gerdeman, Benjamin H. Wilt, Ronald A. Servais, Nicholas J. Olson

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Technical	FROM 830606 TO 840514	1984 June 20	48

16. SUPPLEMENTARY NOTATION
This work was sponsored by the Defense Nuclear Agency under RDT&E RMSS Code B345083466 G54AMXGF00012 H2590D.

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	
14	2		Thermal Facility; Tri-Service; Mobile Quartz Lamp Bank; Data Acquisition and Control System; High Density Lamp Bank

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report outlines facility usage during the period of 6 June 1983-15 May 1984 and lists available instrumentation and projected usage.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL Betty L. Fox	22b. TELEPHONE (Include Area Code) 202-325-7042 22c. OFFICE SYMBOL DNA/STTI

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE

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SUMMARY

The Tri-Service Thermal Radiation Test Facility has conducted approximately 13,000 thermal tests during a seven-year history to evaluate materials response to intense radiant heating. The facility is located at the USAF Wright Aeronautical Laboratories/Materials Laboratory, Wright-Patterson Air Force Base, Ohio. The facility is operated by the University of Dayton Research Institute under contract to the Defense Nuclear Agency.

Of the 12,953 tests conducted to date, 1,674 tests were performed during the twelve months of research under this contract. It is anticipated that a like number of tests will be performed during the next year. Additional capabilities and improvements to the facility are expected. It is anticipated that heat flux capabilities will be greatly increased with the inclusion of a Xenon lamp test capability.

A new data acquisition and control capability was provided during the past year under a separate contract to DNA. This system can accommodate anticipated future testing requirements, such as the Xenon lamp source.

PREFACE

This summary report covers work performed during the period from 6 June 1983 to 15 May 1984 under Defense Nuclear Agency Contract DNA001-83-C-0236. The work was administered under the direction of Lt. Col. Robert A. Flory, Contracting Officer's Representative on this contract. The contract represents a follow-on effort to Defense Nuclear Agency Contract DNA001-82-C-0153 under which the reports described in References 1 through 8 were generated.

This work was conducted under the general supervision of Mr. Dennis A. Gerdeman. Mr. Benjamin H. Wilt was Principal Investigator for the contract. Dr. Ronald A. Servais acted as consultant and the Test Director was Mr. Nicholas J. Olson. Mr. David Lincks, Research Technician, assisted in the laboratory and was instrumental in the installation of the data acquisition and control system.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION 1
INTRODUCTION

1.1 BACKGROUND

The University of Dayton Research Institute (UDRI) has been under contract to the Defense Nuclear Agency (DNA) since 1976 to operate the Tri-Service Thermal Radiation Test Facility located at the Air Force Wright Aeronautical Laboratories (AFWAL), Wright-Patterson Air Force Base, Dayton, Ohio. Efforts in support of the DNA have included the development and operation of appropriate laboratory equipment to simulate thermal, aerodynamic, tensile, and bending loads and combinations of these loading conditions on materials of interest to the Tri-Service community.

The data accumulated through materials exposure to the combined thermal and aerodynamic or thermal and mechanical loads in the thermal flash facility can be utilized to match material performance with design criteria and as a data base for computer modeling.

1.2 OBJECTIVES

The primary objectives of the research activity have remained unchanged since the establishment of the test facility in 1976. These objectives have served to establish a materials data base from approximately 13,000 tests during that time and can be summarized as follows:

(1) Continuation of a quick-response experimental radiant heating test capability to support the Tri-Service community;

(2) Performance of radiant pulse testing including the effects of simultaneous mechanical or aerodynamic loading for the Tri-Service community, as required; and

(3) Maintenance, improvements, and modifications to upgrade the facility between scheduled tests.

SECTION 2
TRI-SERVICE THERMAL RADIATION TEST FACILITY

2.1 OVERVIEW

The original development of the Tri-Service Thermal Radiation Test Facility is described in Reference 1. The facility has undergone numerous improvements to reflect the current needs of the Tri-Service community. There are four basic experimental capabilities:

(1) Irradiation of test specimens using one of several Quartz Lamp Bank (QLB) configurations currently available;

(2) Irradiation of test specimens subjected to aerodynamic flow using a QLB;

(3) Irradiation of test specimens subjected to static tensile or bending loads using a QLB; and

(4) Irradiation of test specimens subjected to dynamic tensile or compressive loads using a QLB.

Available instrumentation include calorimeters for determining heat flux, thermocouples for monitoring temperatures, a pitot tube for determining flow velocities, still and movie cameras, multi-channel recorders, and various electronic control devices. Limited machining facilities are available for minor specimen modification or alteration during test programs.

Figure 1 identifies the major laboratory hardware and illustrates the physical location of the computer control room in the Tri-Service Thermal Radiation Test Facility. The computer control room is shown pictorially in Figure 2.

2.2 THERMAL RADIATION SIMULATION

The intense radiation needed to simulate a thermal flash can be produced by a series or bank of tungsten filament, quartz lamps. Three banks of lamps are available in the Facility; a High Density Lamp Bank (HDLB), a Low Density Lamp Bank (LDLB), and the Mobile Quartz Lamp Bank (MQLB). The operational characteristics

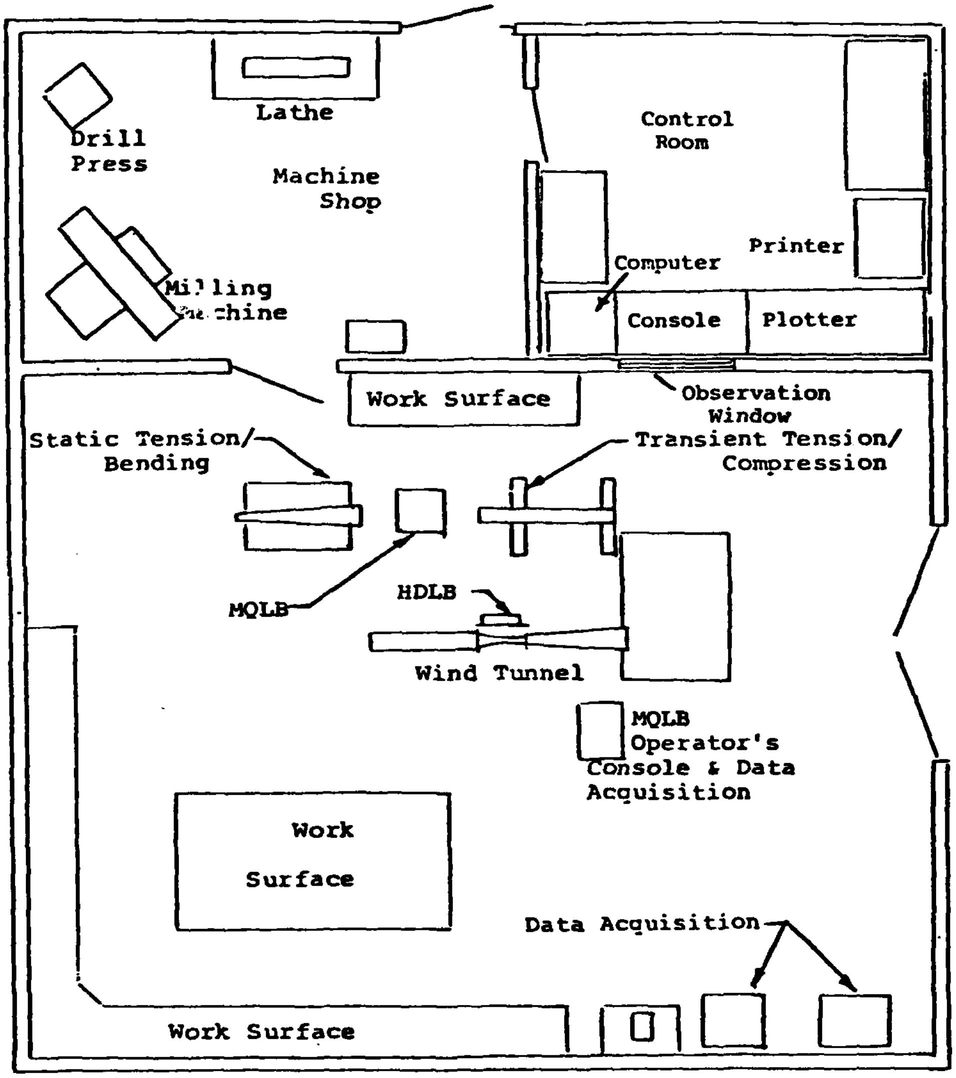

Figure 1. Tri-service thermal radiation test facility.

Figure 2. Control room.

of the banks are listed in Table 1; the HDLB and MQLB are shown in Figure 3 and 4. The HDLB is used to produce very high heat flux levels; the MQLB and LDLB are used when lower heat flux levels are required.

Table 1. Quartz lamp bank specifications.

	MQLB	HDLB	LDLB
Lamp Designation	GE/Q6M/T3/CL/HT	GE/Q6M/T3/CL/HT	GE/Q6M/T3/CL/HT
Number of Lamps	24	24	12
Lamp Bank Area	22 cm x 25 cm	15 cm x 25 cm	15 cm x 25 cm
Maximum Voltage	460 vac	460 vac	460 vac
Maximum Current	300 a	300 a	150 a

The HDLB has two layers of lamps and mounts to the side of the wind tunnel. Use of this one-dimensional radiation source is limited to the 11 cm x 22 cm window that forms one wall of the tunnel. Incident radiation on a test specimen mounted on the opposite wall of the tunnel can only be varied by changing lamp applied voltage. Flux levels to 55 cal/cm^2-sec for durations of up to 3 seconds can be achieved using a gold coated reflector that surrounds the bank, directing most of the radiant energy to the test specimen. Removal of the reflector reduces the heat flux to a level near 30 cal/cm^2-sec. It also allows longer test durations of up to 5 seconds. Reducing lamp voltage for lower flux values further extends allowable test durations, as long as a maximum integrated heat fluence of 150 cal/cm^2 is not exceeded. Higher fluence levels can be achieved with proportionate reductions in both reliability and stability.

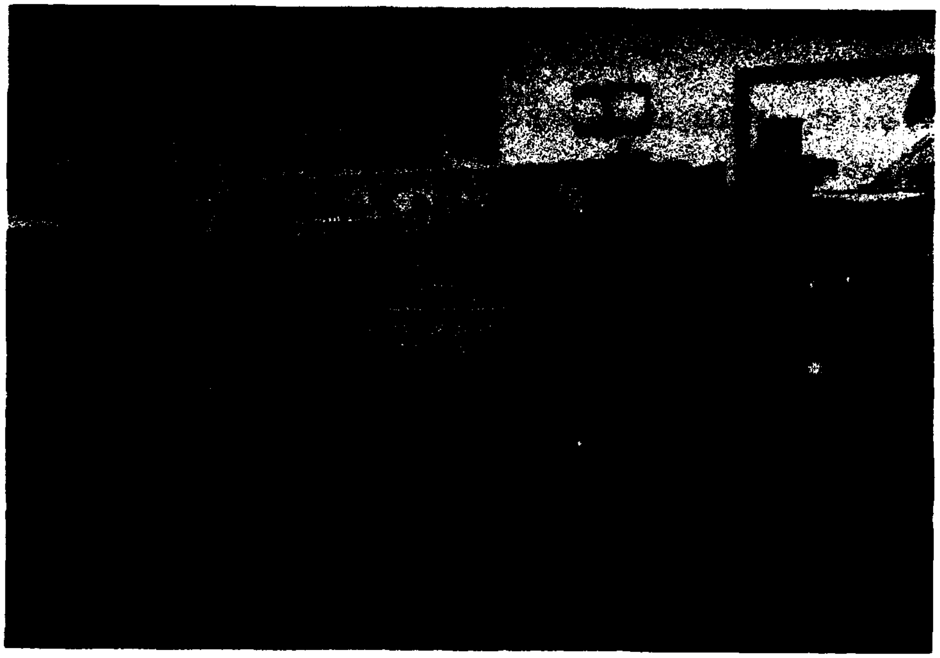

Figure 3. High density lamp bank (low density lamp bank is similar in configuration).

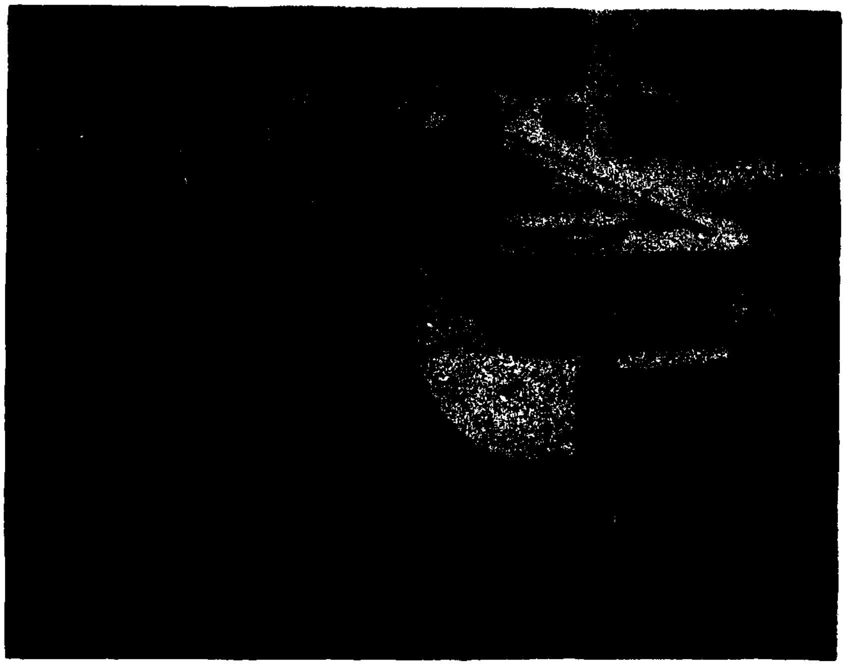

Figure 4. Mobile quartz lamp bank.

The single lamp layer LDLB also mounts to the side of the wind tunnel. The reduced number of lamps allows low flux levels without decreased current flow thereby improving flux level stability.

Tunnel operation is not necessary for HDLB and LDLB use, but the slight air flow across the face of the test specimen prevents possible occlusion by carrying off any byproducts of combustion.

The MQLB with its larger area produces a one-dimensional radiation source, approximately 20 cm by 25 cm. The incident radiation on a test specimen is controlled by varying either specimen distance from the lamp source or the lamp applied voltage. Certain tests require protecting the lamps; this is normally accomplished by inserting a quartz window between the lamps and the exposed specimen.

2.3 AERODYNAMIC LOAD SIMULATION

An open-circuit pull-down wind tunnel is available to simulate aerodynamic flow over specimens exposed to high intensity radiation. The wind tunnel is shown in Figure 5. A photograph of the wind tunnel test section is shown in Figure 6. The test section is 70 cm long and has a 2.38 cm x 11.43 cm cross-sectional area. The constant free-stream velocity for the section is nominally 210 m/sec with a corresponding Mach number of 0.6. The Reynolds number is 20×10^6 based on the inlet wall length. Wind tunnel exhaust gases are vented to the atmosphere through the roof of the building.

A pitot probe, manometers, and a pressure transducer are available for flow calibration, which can be supplied with each test program, as required.

The HDLB or LDLB must be used in conjunction with the wind tunnel; the MQLB may also be used in a wind tunnel configuration.

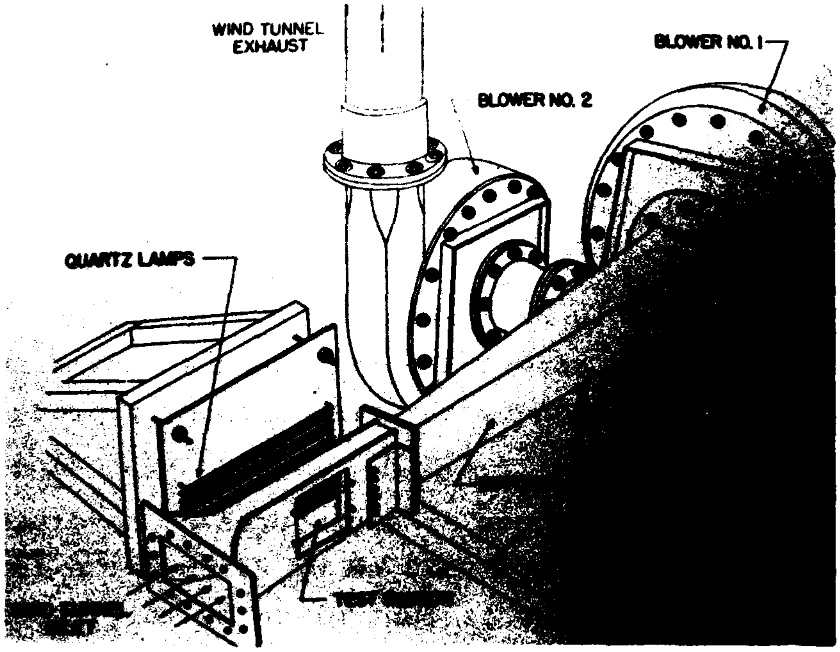

Figure 5. Wind tunnel.

Figure 6. Wind tunnel 70 cm test section.

The beam is brought in through a quartz window which is mounted in one wall of the test section. The opposite wind tunnel test section wall holds the test specimen, which is mounted flush with the wind tunnel wall. Specimen sizes up to 22.86 cm by 10.08 cm can be accommodated. Special plates are available for the test section for mounting the various calorimeters and pitot tube for heat flux and flow calibration.

A pneumatically actuated shutter for the wind tunnel test configuration is contained in the 70 cm test section. Lamp-to-specimen distance and maximum heat flux available are not affected by the shutter. The rapid rise and accurately controlled pulse attained with the shutter capability enhances cimulation of thermal flash heating. A photograph of the shutter installation in the 70 cm test section is shown in Figure 7.

2.4 DYNAMIC LOAD SIMULATION

A Materials Test System (MTS) device is available for simulating dynamic loads during exposure to radiant heating. The MTS device includes a hydraulically actuated mechanism for applying tensile or compressive loads to a specimen, as pictured in Figure 8. The loads are preset and controlled electronically; specific control components which are available are listed in Table 2. Simultaneous dynamic loads and radiant heating effects on specimens can be determined. The system is designed in order to conduct simultaneous dynamic loading in air flow while exposing the test specimen to radiant heating; this capability is a first priority improvement in the follow-on contract effort.

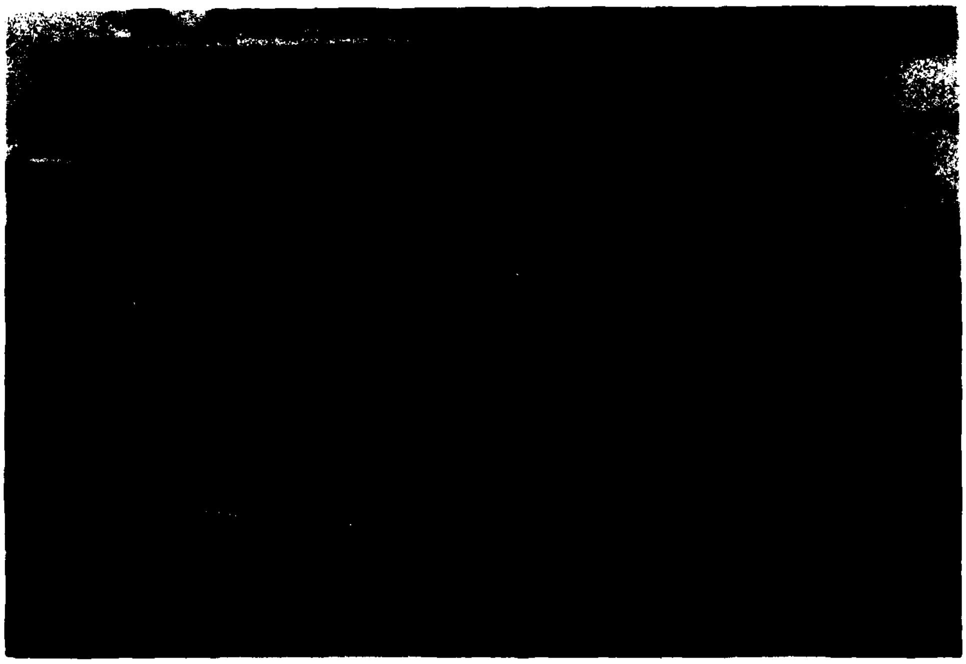

Figure 7. 70 cm test section shutter.

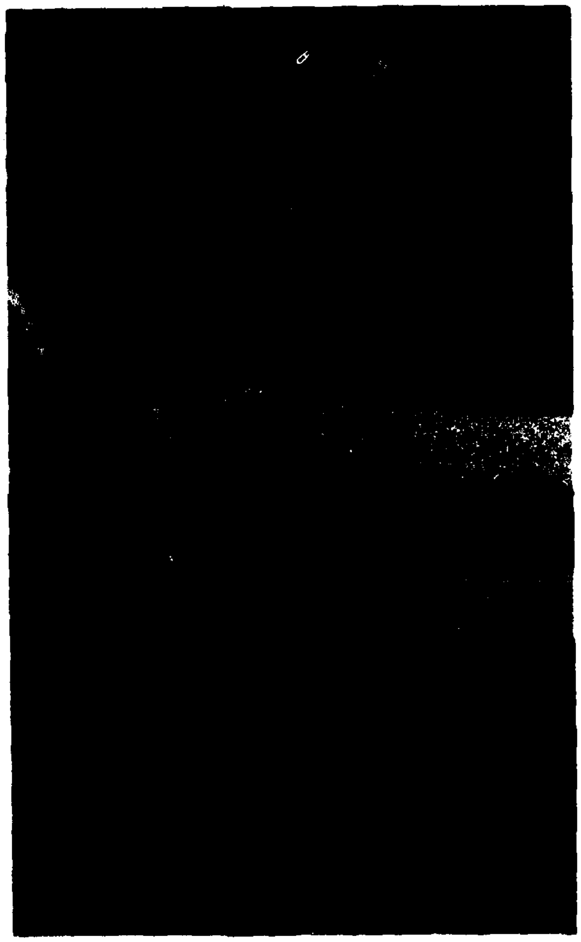

Figure 8. MTS tensile loading device.

Table 2. MTS operating system components

Component	Model
Linear Actuator	204.51
Hydraulic Manifold	294.11
Digital Function Generator	410.31
Electro-mechanical Counter	417.01
Servo Controller	440.13
DC Transducer Conditioner	440.21
AC Transducer Conditioner	440.22
Servo-controlled Closed Loop Feedback Selector	440.31
Limit Detector	440.41
Ramp Generator	440.91
Controller	442.11
Hydraulic Power Supply	506.03
Transducer Load Cell	661.21

2.5 MECHANICAL LOAD SIMULATION

A creep frame is available for dead weight simulation of tensile and bending loads and is shown in Figure 9. The MQLB is used as the radiation source; the exposure procedure is similar to that used in the wind tunnel. Note that mechanical and aerodynamic loads cannot be applied simultaneously at this time. Tension and bending configurations are possible. Three and four point bending is accomplished in the mechanical load frame by the addition of a yoke and fulcrum as indicated in Figure 10. Recommended specimen sizes and maximum applied loads are specified in Table 3. Strain gages and other appropriate instrumentation are mounted on test specimens in order to monitor strain as a function of time during exposure to radiation.

Table 3. Recommended* mechanical loading specimen information.

Specimen Size	Tension	Bending/ Compression
Width	1 in. (2.5 cm) max.	2 in. (5 cm) max.
Thickness**	0.25 in. (0.6 cm) max.	2 in. (5 cm) max.
Length**	17 in. (43 cm) min.	18 in. (45 cm) nom.
Stress Levels (MPa)	3.5-1700	7-1400

* not limited to
** including grip tabs

2.6 INSTRUMENTATION

Available instrumentation required for operating the facility is summarized in Table 4. Facility users normally supply their own specimen-mounted instrumentation, such as thermocouples and strain gages. Additional details on the heat flux instrumentation and plotters which are available are given in Tables 5 and 6.

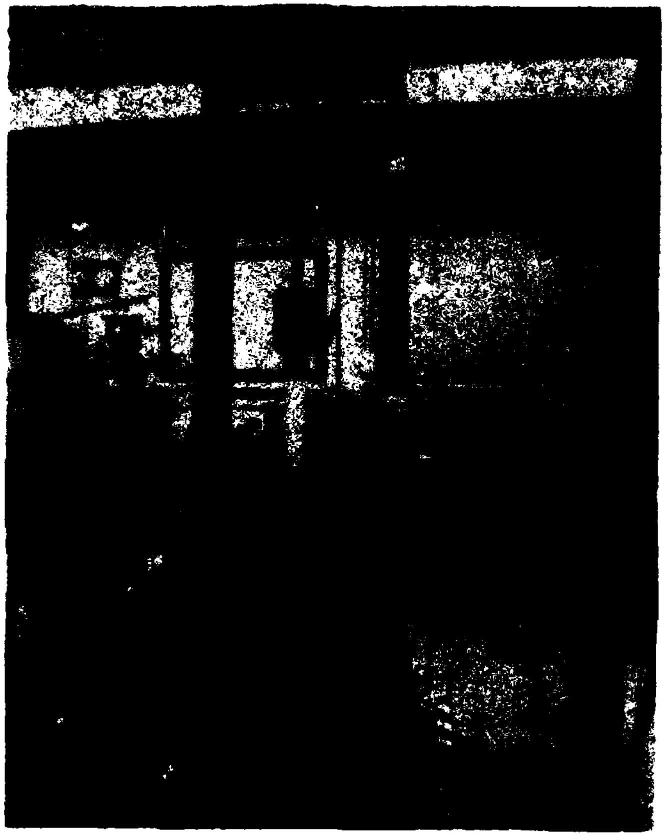

Figure 9. Mechanical loading-tension.

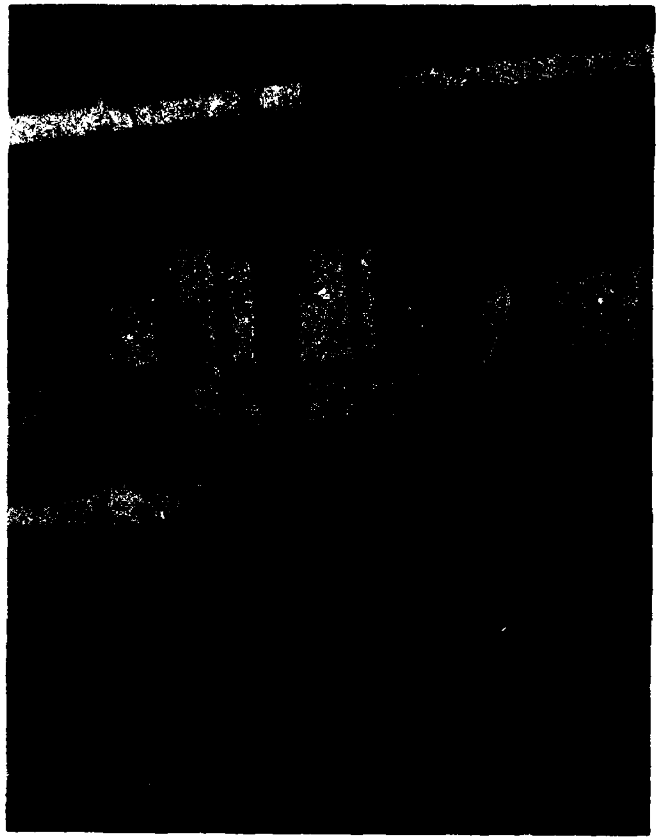

Figure 10. Mechanical loading-bending.

Table 4. Available instrumentation.

Application	Quantity	Instrumentation	Purpose
Quartz Lamp Banks	10	Radiometers	Heat Flux
	2	Slug Calorimeters	Heat Flux
	2	Hy-Cal Asymptotic Calorimeters	Heat Flux
	1	*Photronic Cell*	*Timing*
Aerodynamic Load	1	±10 psi Stathem Pressure Transducer	Flow Calibration
	1	Pitot Probe Assembly	Flow Calibration
	1	Manometer	Flow Calibration
Mechanical Load	1	Wheatstone Bridge*	Strain Gage
	1	LVDT*	Linear Motion
Timers	1	Closed Loop Power Controller	Heat Flux Control
	1	Electronic Timer	Shutter and Two Voltage Lamp Controls
	1	Data-Trak Controller	Heat Flux Control
General	2	X-Y-Y' Recorders	Data Recording
	1	LSI-11 Microprocessor	Data Recording
	1	Dual Trace Storage Oscilloscope	Data Recording
	1	6 Channel Strip Recorder	Data Recording
	1	35mm Nikon Still Camera	Specimen Photographs
	1	MP-4 Polaroid Still Camera	Specimen Photographs
	2	8mm Nizo Braun Movie Cameras	Specimen Photographs
	-	Various Thermocouples	Temperature
	1	L&N 8641-S Automatic Recording Pyrometer(760-6000°C)	Surface Temperature
	-	Barometer, Thermometer, Hygrometer	Ambient Conditions
	1	Keithley Digital Voltmeter	Voltages
	1	L&N K-4 Potentiometer	Calibrations

* Not On Site

Table 5. Calorimeter specifications.

Mfgr	Type	Model	Range	Accuracy
Hy-Cal	Asymptotic	C-1312-A	80 cal/cm^2-sec	$\pm 3\%$
Hy-Cal	Asymptotic	C-1312-A	80 cal/cm^2-sec	$\pm 3\%$
Hy-Cal	Asymptotic	C-1312-A	200 cal/cm^2-sec	$\pm 3\%$

Table 6. Recorder specifications.

Mfgr	Model	Channels	Range	Response
Hewlett-Packard	7046A X-Y-Y'	2	0.2mv/cm-4v/cm	0.025-5cm/sec
Hewlett-Packard	136 X-Y-Y'	2	0.2mv/cm-20v/cm	0.05-5cm/sec
Honeywell	540 X-Y-Y'	2	0.04mv/cm-0.4v/cm	0.025-5cm/sec
Soltec	3316	6	0.04mv/cm-0.4v/cm	135cm/sec

2.7 DATA ACQUISITION SYSTEM

The computer system includes an LSI-11/23 Plus central processor manufactured by Digital Equipment Corporation; this CPU is frequently utilized in laboratory environments and extensive hardware, software, and other support is available. Six serial ports are included along with two floppy disk drives and a Winchester hard disk. The CPU, in a direct memory access state (DMA) is capable (with the digital to analog conversion board described below) of 30000 samples per second on a single channel; this should be more than adequate for all

applications envisioned and substantially faster than the previous capability of 10 samples per second on a single channel. A real time clock is also included. The computer system utilizes a Q-bus; 16 dual board slots are available, of which 13 are now used. Major computer components are identified in Figure 11 and the computer hardware is itemized in Table 7. If necessary, additional ram memory could be included in the system.

2.8 ANALOG SIGNAL INTERFACES

The typical signal of interest in the Tri-Service Thermal Radiation Test Facility is in the form of millivolts from thermocouples, calorimeters, and radiometers, although other signals are occasionally generated. Since the quartz lamp banks use large amounts of power (typically 440 volts at 480 amps), electrical noise is a problem which requires special handling of the millivolt signals. Signal conditioning is used to minimize the noise effects.

The system which has been installed accommodates up to 16 channels of voltage inputs; signal conditioning amplifiers are available for ten of the channels. Additional input boards could be added to the system at a later date. Four channels of voltage output are available along with one channel for controlling the lamp power supply. Relays are also available for switching control capability. The list of analog signal conditioning and conversion hardware is shown in Table 8.

2.9 PERIPHERAL HARDWARE

The peripheral hardware consists of two graphics terminals, a printer, a plotter, and a modem. These devices allow for control of the computer from the console located in the control room, a test operator to control the computer from a convenient location, printed and/or plotted output, and telephone communications with other computers for transferring data. All devices utilize a standard RS-232-C interface. They are also listed in Table 7.

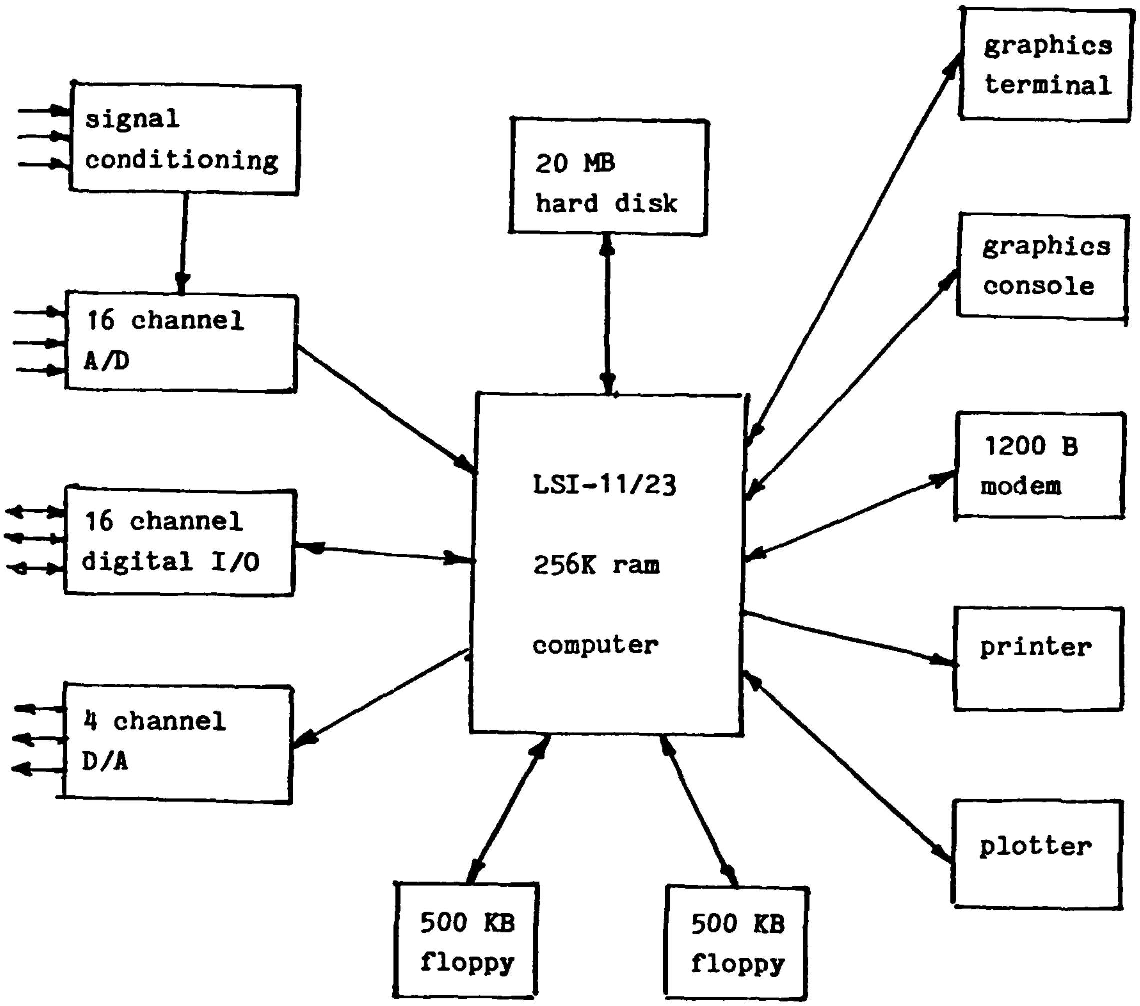

Figure 11. Data acquisition and control system.

Table 7. Computer hardware summary.

DataRam Model A22B Minicomputer
DEC LSI-11/23 Plus Processor
Floating Point Option
256 K Bytes Ram Memory
Two 500 K Bytes Eight Inch Floppy Disk Drives
20 M Bytes Winchester Disk Drive
Four Serial RS-232 Ports
Two Serial RS-232 Console Ports
Data Translation Programmable Real Time Clock
Sixteen Dual Board Q-Bus Slots
DEC VT-240 Graphics Console Terminal
Visual Technology V-550 Graphics Operator Terminal
Okidata Model 2350 Pacemark Dot Matix Line Printer
Hewlett-Packard Model 7475A 6-Pen Plotter
Racal-Vadic VA212PA 300/1200 Baud Auto Dial/Answer Modem

Table 8. Analog interface summary.

Data Translation DT750 Backplane for Sixteen Conditioning Modules
Data Translation DT6792 Power Supply for Signal Conditioning Modules
Data Translation DT6702 Low Level Signal Conditioning/Amplifying Modules (Ten Modules Total)
Data Translation DT6706 Output Module for Tri-Phasor Control
Data Translation DT2762-SE-PG Sixteen Channel, 12 Bit, Programmable Gain, Analog to Digital Voltage Conversion Board
Data Translation DT2766 Four Channel, 12 Bit, Digital to Analog Voltage Conversion Board
Data Translation DT2768-I Sixteen Channel, Parallel, Digital Input/Output Board
ADAC 1632/HCO 32 Channel, Discrete Latched, High Current Board
ADAC 1616/MIC 16 Channel, Multiple Interrupt Encoder Board

2.10 CONTROL SYSTEM

The primary components of the laboratory (quartz lamp banks, wind tunnel, exhaust system) can be controlled and monitored from the operator console, which is shown in Figure 12. The console is located such that the operator can visually observe a test (if appropriate) and also monitor critical test parameters. This allows the operator to abort a test if necessary.

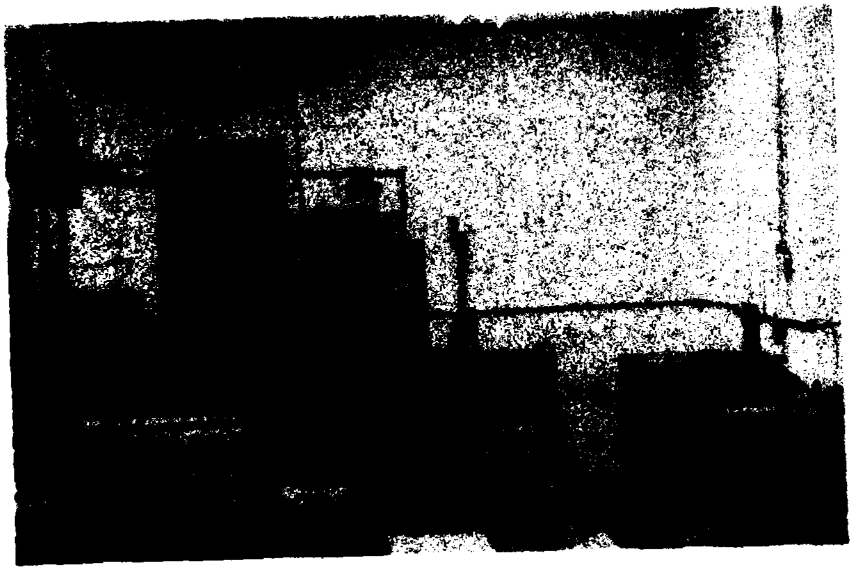

Figure 12. Console.

Figure 13. Thermal radiation laboratory overview.

SECTION 3
FACILITY UTILIZATION

3.1 TEST SCHEDULING

The Tri-Service Thermal Radiation Test Facility is available to governmental users on a no-charge basis. Test programs involving thermal flash materials performance receive priority although other tests may be accommodated; all test programs must be approved by the Defense Nuclear Agency contract monitor.

Specific details regarding test program procedures, scheduling, special testing requirements, specimen sizes, heat flux levels, etc., should be directed to the Test Director in charge of the Facility, Mr. Nicholas Olson (513-253-7166). Note that the analysis of material performance must be conducted by the Facility user.

Material response tests for the Tri-Service community take precedence over all other activities associated with the operation of the Facility. That is, test requests are scheduled at the test initiator's convenience if possible. Since most test programs are about one to five days in length, few conflicts in scheduling have arisen and few are anticipated. Based on experience, each new test program typically requires special planning and hardware (such as instrumentation and specimen mounting brackets); therefore, the more advance notice given for a particular test program the more efficiently the tests can be conducted. All test scheduling, special requirements, etc., have been and will be handled by the Test Director, Mr. Nicholas Olson.

3.2 COMPLETED TEST PROGRAMS

The primary purpose of the Facility is to support the Tri-Service community with a quick-response, thermal radiation, materials response testing capability. Tests which have been

conducted are summarized in Table 9. Additional information on these tests can be obtained by contacting Mr. Nicholas Olson.

3.3 PROJECTED TEST PROGRAMS

Table 10 identifies the known tests to be conducted during the next 12 months. Since the primary purpose of the Facility involves quick-response testing, it is not possible to establish a comprehensive list of all future tests at this time.

Table 9. Completed and current test programs.

Initiator	Organization	Project	Test Number	Test Date
Alexander	AVCO	DNA	001-073	March 7-10, 1977
Alexander	AVCO	DNA	074-086	March 15, 1977
Collis	Boeing	AWACS	087-316	March 21-24, 1977
Graham	AVCO	DNA	359-416	June 6-16, 1977
Alexander	AVCO	DNA	419-574	June 20-24, 1977
Collis	Boeing	ALCM	576-677	July 19-22, 1977
Alexander	AVCO	DNA	678-772	Oct. 5-7, 1977
Grady	AFWAL	DNA	773-870	Oct. 12-22, 1977
Litvak	AFWAL	B-1	Documentary Film	March 13-24, 1978
Collis	Boeing	ALCM	871-1076	July 18-20, 1978
Sparling	Rockwell	DNA	1081-2571	July 24-Sept. 28, 1978
Worscheck	GD-Convair	ALCM	2572-2677	Oct. 2-4, 1978
Olson	UDRI	Calibration	2678-2710	Oct. 16-20, 1978
Sparling	Rockwell	DNA	2711-5753	Oct. 24-Dec. 5, 1978
Alexander	AVCO	DNA	5754-5809	Dec. 11-13, 1978
Baba	Harry Diamond	U.S. Army	5810-5881	Dec. 18-21, 1978
Olson	UDRI	Calibration	5882-5890	Jan. 22, 1979
Evans	Ballistics Research	U.S. Army	5891-5948	Jan. 23-24, 1979
Spangler	MCDAC	DNA	5949-6032	March 6-15, 1979
Rooney	AFWAL	USAF	6033-6036	March 19, 1979
Spanlger	MCDAC	DNA	6037-6056	April 2, 1979
Worscheck	GD-Convair	ALCM	6057-6074	May 2, 1979
Kimerly	LATA	DNA	6075-6096	May 31-June 1, 1979
Alexander	AVCO	DNA	6097-6140	June 19-21, 1979
Baba	Harry Diamond	U.S. Army	6141-6222	June 25-27, 1979
Schmitt	AFWAL	USAF	6223-6247	June 28-29, 1979
Kimerly	LATA	DNA	6248-6264	July 2-3, 1979
Worscheck	GD-Convair	ALCM	6265-6307	July 17-19, 1979
Spangler	MCDAC	DNA	6308-6372	July 30-Aug. 2, 1979
Schmitt	AFWAL	USAF	6373-6423	Aug. 14-16, 1979
Schmitt	AFWAL	USAF	6424-6426	Aug. 30, 1979
Worscheck	GD-Convair	ALCM	6427-6435	Sept. 4, 1979
Schmitt	AFWAL	USAF	6436-6438	Oct. 3, 1979
Alexander	AVCO	DNA	6439-6449	Oct. 5-10, 1979
Olson	UDRI	DNA	6450-6466	Oct. 15-19, 1979
Rooney	AFWAL	USAF	6467-6470	Nov. 11, 1979
Kimerly	LATA	DNA	6471-6480	Dec. 4-6, 1979

Table 9. Completed and current test programs (continued).

Initiator	Organization	Project	Test	
			Number	Date
Etzel	Aerojet-General	DNA	6481-6555	Dec. 10-13, 1979
Kimerly	LATA	DNA	6556-6561	Dec. 14, 1979
Hurley	AFWAL	USAF	6562-6598	Dec. 17-21, 1979
Sherwood	CAAPCO	USAF	6599-6634	Jan. 22, 1980
Sherwood	CAAPCO	USAF	6635-6639	April 2, 1980
Hurley	AFWAL	USAF	6640-6647	April 8, 1980
Kimerly	LATA	DNA	6648-6666	May 8, 1980
Tydings	AFWAL	USAF	6467	May 13, 1980
Etzel	Aerojet	MX	6468-6742	June 4-10, 1980
Henders	McDAC	MX	6743-6755	June 12, 1980
Etzel	Aerojet	MX	6756-6881	July 7-10, 1980
Walsh	Boeing-Wich.	B-52	6882-7040	July 14-18, 1980
Kimerly	LATA	DNA	7041-7088	Aug. 20-23, 1980
Tydings	AFWAL	USAF	7089-7090	Aug. 27, 1980
Etzel	Aerojet	MX	7091-7206	Sept. 22, 1980
Church	Boeing-Wich.	B-52	7207-7211	Oct. 1, 1980
Tydings	AFWAL	USAF	7212	Oct. 14, 1980
Kimerly	LATA	DNA	7213-7232	Oct. 16-18, 1980
Rhodehamel	AFWAL	USAF	7233-7258	Nov. 4-10, 1980
Olson	UDRI	DNA	7259-7280	Nov. 11-14, 1980
Rhodehamel	AFWAL	USAF	7281-7295	Nov. 19-25, 1980
Etzel	Aerojet	MX	7296-7488	Dec. 1-5, 1980
Schuck	Collins Radio	USAF	7489-7626	Dec. 15, 1980
Schuck	Collins Radio	USAF	7627-7636	Feb. 5, 1981
Davis	Sperry-Univac	MX	7637-7641	Feb. 17, 1981
Tydings	AFWAL	USAF	7642-7645	March 16, 1981
Hender	Aerojet	MX	7646-7799	March 30, 1981
Grinsberg	CAAPCO	USAF	7800-7903	April 7, 1981
McDonnell	SAI	DNA	7904-8057	April 20, 1981
Lane	Aerojet	MX	8058-8150	April 27, 1981
Olson	UDRI	DNA	8151-8157	May 6, 1981
Sparling	Rockwell	USAF	8158-8184	May 7, 1981
Kimerly	LATA	DNA	8185-8242	May 15, 1981
Olson	UDRI	DNA	8243-8253	June 1, 1981
Schuck	Collins Radio	USAF	8254-8266	June 12, 1981
Hender	Aerojet	MX	8267-8268	June 16, 1981
Gregory	Aberdeen	U.S. Army	8269-8294	June 29, 1981
Freeberg	LATA	DNA	8295-8360	July 6, 1981
Griffith	Sperry-Univac	MX	8361-8396	July 13, 1981
Davis	Sperry-Univac	MX	8397-8405	Aug. 26, 1981
Grinsberg	CAAPCO	USAF	8406-8443	Aug. 27, 1981
Price	LATA	DNA	8444-8474	Aug. 29, 1981
Etzel	Aerojet	MX	8475-8658	Aug. 31, 1981

Table 9. Completed and current test programs (continued).

Initiator	Organization	Project	Test	
			Number	Date
Hurley	AFWAL	USAF	8659-8663	Sept. 17, 1981
Worscheck	GD-Convair	USAF	8664-8708	Sept. 22, 1981
Hand	I-T-T	USAF	8709-8719	Oct. 1, 1981
Miller	UDRI	NASA	8720-8724	Oct. 5, 1981
Uram	Goodyear	USAF	8725-8751	Oct. 9, 1981
Price	LATA	DNA	8752-9246	Oct. 19, 1981
Dumus	Collins Radio	USAF	9247-9302	Nov. 5, 1981
---	LATA	DNA	9303-9375	Nov. 12, 1981
---	LATA	DNA	9376-9389	Nov. 18, 1981
Miller	UDRI	NASA	9390-9405	Nov. 19, 1981
Uram	Goodyear	USAF	9406-9431	Dec. 15, 1981
Monti	Martin-Marietta	USAF	9432-9510	Dec. 21, 1981
R. Davis	Brunswick	USAF	9511-9538	Dec. 28, 1981
Olson	UDRI	DNA	9539-9548	Jan. 12, 1982
Monti	Martin-Marietta	USAF	9549-9642	Jan. 18, 1982
Miller	UDRI	NASA	9643-9647	Feb. 2, 1982
Monti	Martin-Marietta	USAF	9648-9728	March 8, 1982
Miller	UDRI	NASA	9729-9747	March 22, 1982
Miller	UDRI	NASA	9748-9765	April 14, 1982
Grinsberg	Caapco	USAF	9766-9846	May 10, 1982
Brettman	Boeing	USAF	9847-9986	July 13, 1982
Lane	McDAC	USAF	9987-10110	Aug. 3, 1982
Hender	Aerojet	USAF	10111-10166	Aug. 9, 1982
Davis	Sperry Univac	USAF	10167-10172	Sept. 13, 1982
Lane	McDAC	DNA	10173-10286	Sept. 29, 1982
Olson	UDRI	DNA	10287-10321	Oct. 26, 1982
Hender	Aerojet	USAF	10322-10339	Nov. 8, 1982
Olson	UDRI	DNA	10340-10418	Nov. 18, 1982
Hurley	AFWAL	USAF	10419-10545	Dec. 13, 1982
Hender	Aerojet	USAF	10546-10558	Dec. 21, 1982
Tydings	AFWAL	USAF	10559-10560	Dec. 22, 1982
Griffen	UDRI	NASA	10561-10567	Dec. 28, 1982
Olson	UDRI	DNA	10568-10715	Jan. 14, 1983
Zimmerman	Harris	USAF	10716-10756	Feb. 14, 1983
Olson	UDRI	DNA	10757-10761	Feb. 25, 1983
McGiness	Boeing	DNA	10762-10969	Feb. 28, 1983
Olson	UDRI	DNA	10970-11035	March 4, 1983
Hoffman	LATA	DNA	11036-11139	March 7, 1983
Frank	Northrup	USAF	11140-11222	March 15, 1983
Hender	Aerojet	USAF	11223-11241	March 22, 1983
Olson	UDRI	DNA	11242-11261	March 28, 1983
Lamb	3M	USAF	11262-11266	March 30, 1983
Olson	UDRI	DNA	11267-11272	April 5, 1983
Halliwell	AFWAL	USAF	11273-11278	April 21, 1983

Table 9. Completed and current test programs (concluded).

Initiator	Organization	Project	Test Number	Test Date
Brettman	Boeing	USAF	11279-11467	April 25, 1983
Flaska	McDonnell Aircraft	USAF	11468-11605	May 16, 1983
Uram	Goodyear	USA	11606-11623	May 24, 1983
Sawdy	Boeing-Wick	DNA	11624-11630	May 25, 1983
Garry	Northrop	USAF	11631-11724	June 6, 1983
Hoffman	Lata	DNA	11725-11869	June 14, 1983
Uram	Goodyear	USA	11870-11883	June 22, 1983
Hender	Aerojet	USAF	11884-11949	July 6, 1983
Ho	Vought	DNA	11950-11987	July 11, 1983
Davis	Sperry-Univac	USAF	11988-12007	Aug. 23, 1983
Hender	Aerojet	MX	12008-12043	Sept. 22, 1983
Moraveck	CAAPCO	USAF	12044-12151	Sept. 27, 1983
Toor	GD Convair	USAF	12152-12243	Nov. 1, 1983
Etzel	Aerojet	USAF	12244-12539	Dec. 5, 1983
Corbin	Martin-Marietta	NASA	12540-12558	Dec. 19, 1983
Zander	UDRI	DNA	12559-12578	Jan. 16, 1984
Green	General Research	DNA	12579-12611	Jan. 31, 1984
Corbin	Martin-Marietta	NASA	12612-12627	Feb. 6, 1984
Manfredi	Raytheon	USN	12628-12662	Feb. 8, 1984
Corbin	Martin-Marietta	NASA	12663-12667	Feb. 17, 1984
Clayton	UDRI	NASA	12668-12691	Feb. 22, 1984
Toor	GD Conv.	USAF	12692-12758	Feb. 29, 1984
Johnson	AFWAL/MLBC	USAF	12759-12780	March 5, 1984
Citrin	McDonnell Aircraft	USAF	12781-12886	March 12, 1984
Eash	Boeing-Seattle	USAF	12887-12953	May 22, 1984

Table 10. Projected test programs.

Initiator	Organization	Project	Material	Date
Brettman	Boeing-Seattle	DNA	Aircraft Composites	June
DuBord	CAAPCO	USAF	Aircraft Coatings	July
Hammond	Boeing-Seattle	USAF	Aircraft Composites	July
Hender	Aerojet	DNA	Aircraft Coatings	July
Hender	Aerojet	DNA	Aircraft Coatings	Aug.
Kay	Boeing-Seattle	USAF	Aircraft Composites	Sept.
Annala	Martin-Marietta	USAF	Composites	Nov.

SECTION 4
FACILITY DEVELOPMENT

4.1 FACILITY MAINTENANCE AND IMPROVEMENTS

Twenty-five test programs comprising 1,674 materials tests were completed between April 1983 and May 1984. The time between testing was utilized for upkeep and maintenance of the facility.

Test programs have become more sophisticated with increased data gathering requirements and facility operating parameters. The incorporation of an LSI 11/23 data acquisition and control system to be completed in June 1984 is a significant improvement in that regard. This self-contained system, dedicated solely to the Thermal Radiation Test Facility can accommodate more than 16 channels of input. It includes a printer, plotter, graphics screen, a telephone modem, and appropriate signal conditioning and conversion hardware for both analog input and output.

Efforts are also continuing to further develop front face photography and pyrometry during test. Photographic coverage of several external protection materials at lower heat flux levels was successfully used to study surface reactions to radiant heating.

4.2 FACILITY ADDITIONS

The Defense Nuclear Agency has sponsored the design and construction of a HIGH FLUX FLASHLAMP THERMAL TEST FACILITY which is scheduled to be co-located with the TRI-SERVICE THERMAL RADIATION TEST FACILITY at WPAFB during the 4th quarter FY85. The FLASHLAMP is a hybrid system comprising a bank of 31 xenon flashlamps and a vortex stabilized CW argon arc lamp. Individual flashlamps are fired at preselected intervals to provide a high-fidelity representation of the time evolution of

the nuclear flux waveform; appropriate fluences (flux integrated over time) for each waveform are obtained using the flashlamps in conjunction with the vortex stabilized arc lamp (VSAL), as required. The VSAL is utilized independently of the flashlamps to permit simulating low-flux weapon's yields.

Nuclear waveforms are developed for various weapons yields and ranges using the Nuclear Waveform Estimator. The estimator utilizes user specified parameters (e.g., weapon yield, burst altitude) to synthesize the nuclear waveform. The Flashlamp Synthesis Estimator is then used to reproduce the calculated waveform. A computer graphics feature permits inspection of the flashlamp simulation prior to testing.

The area irradiated using the standard flux director adaptor is 100 cm^2, although customized adaptors have been used to expand the area to 154 cm^2. The system can be configured to tailor areas of irradiation to user needs, within the limitations of maximum radiant output.

The flashlamp/VSAL based simulator offers important advantages over other nuclear thermal simulation systems including:

- high color temperature (i.e., accurate spectral simulation)
- high peak flux and high fluence capability available in one system
- accurate reproduction of the pulse shape (flux vs. time) of a nuclear burst
- very reproducible pulse (typically $\pm 1\%$)
- clean system (no debris)
- small, compact, indoor system
- no set-up time between shots
- multiple shots per day

Further information about the Flashlamp Facility can be obtained by contacting Mr. Nicholas Olson at the TRI-SERVICE FACILITY, WPAFB.

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